

HIRAD status report to GRIP

Tim Miller, NASA/MSFC

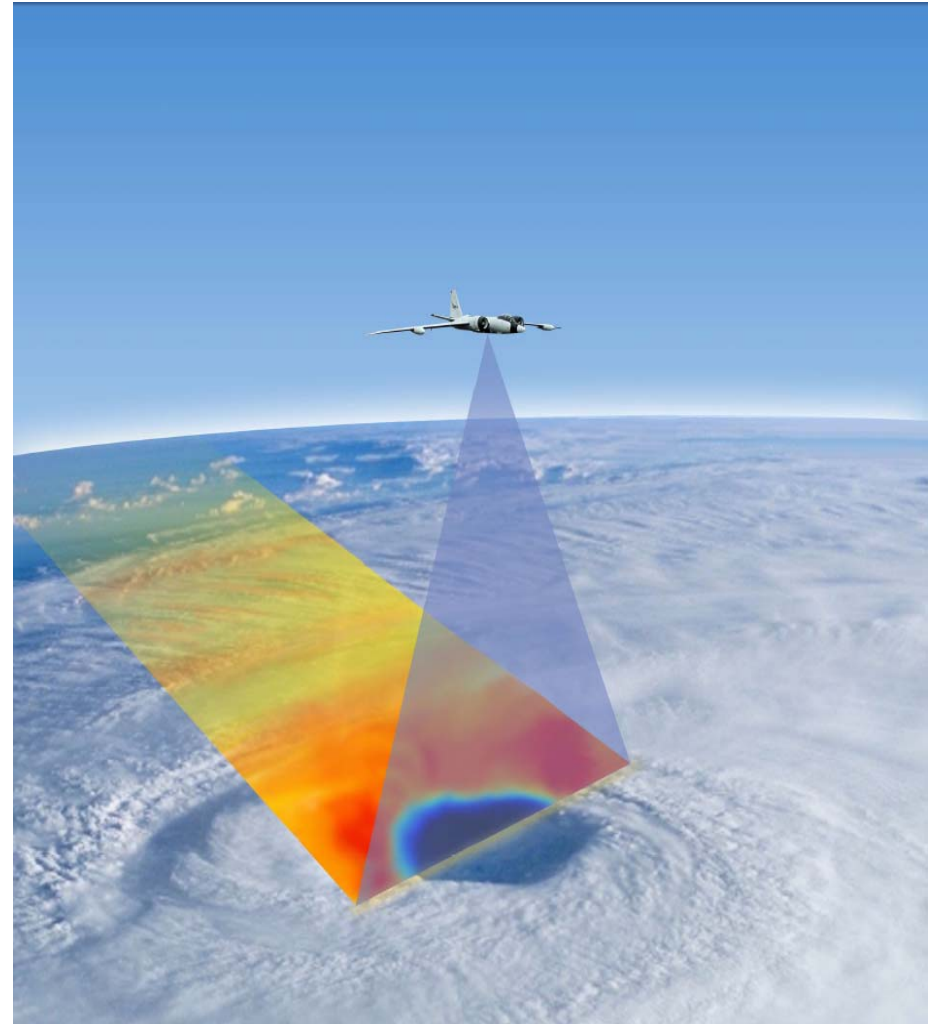
9 May 2012

HIRAD Team

- **Dr. Timothy Miller**, *NASA/MSFC, P.I.*
 - *Atmospheric modeling, project management*
- **Mark James**, *NASA/MSFC, Lead engineer*
- **Dr. Linwood Jones**, *U. Central Fla., Co-I*
- **Dr. Chris Ruf**, *U. Mich., Co-I and lead instrument scientist*
- **Dr. Eric Uhlhorn**, *NOAA/AOML/HRD, Co-I*
- **Dr. J. Brent Roberts**, *NASA/MSFC, Co-I*
- **Dr. Sayak Biswas**, *NASA Post-Doc, MSFC*
- **Dr. Peter Black**, *SAIC/NRL Monterey, consultant*
- **Robbie Hood**, *NOAA sponsor and original P.I.*

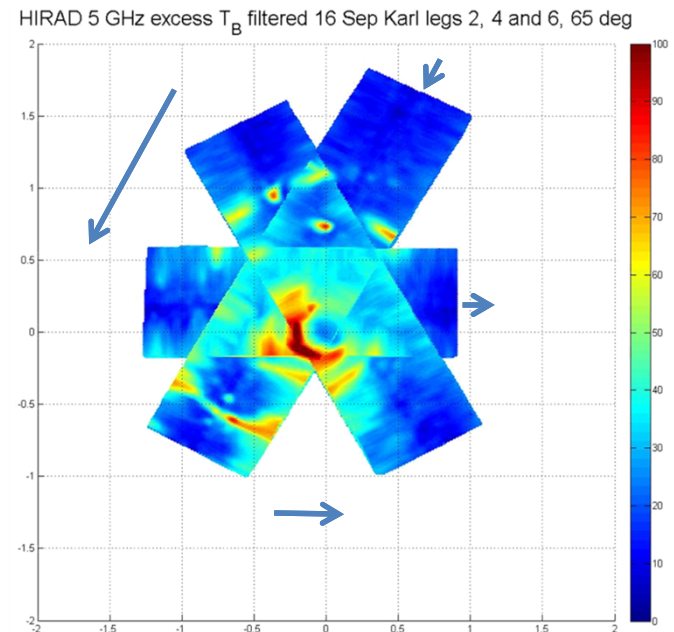
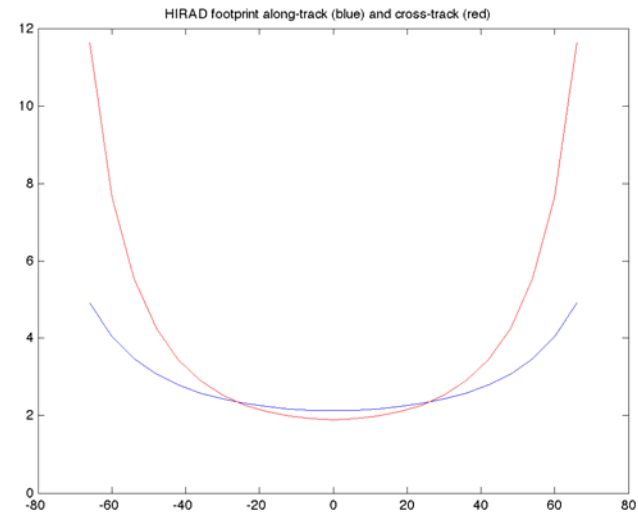
Hurricane Imaging Radiometer (HIRAD)

- A passive microwave radiometer (C-band, 4 frequencies), similar to SFMR: Measures emissivity and retrieves hurricane surface wind speeds and rain rates over a wide-swath:
 - Swath Width ~ 80 km
 - Resolution ~ 2 - 5 km
 - Wind speed ~10 – 85 m/s
 - Rain rate ~ 5 – 100 mm/hr
- Near-instantaneous mapping of entire inner-core hurricane surface wind field and rain structure.
- Surface wind and rain swath complements SFMR and airborne Doppler radar mapping of inner-core structure for improved short-term advisories and numerical model simulations.



HIRAD data products

- Brightness temperatures (T_B)
 - 4, 5, 6, 6.6 GHz
 - Footprint sizes, function of nadir angle, shown on the right
- “Excess” T_B
 - Difference from modeled cross-track profile
 - Example on the right
- Storm center (at crossing times)
- Wind speed, rain rate



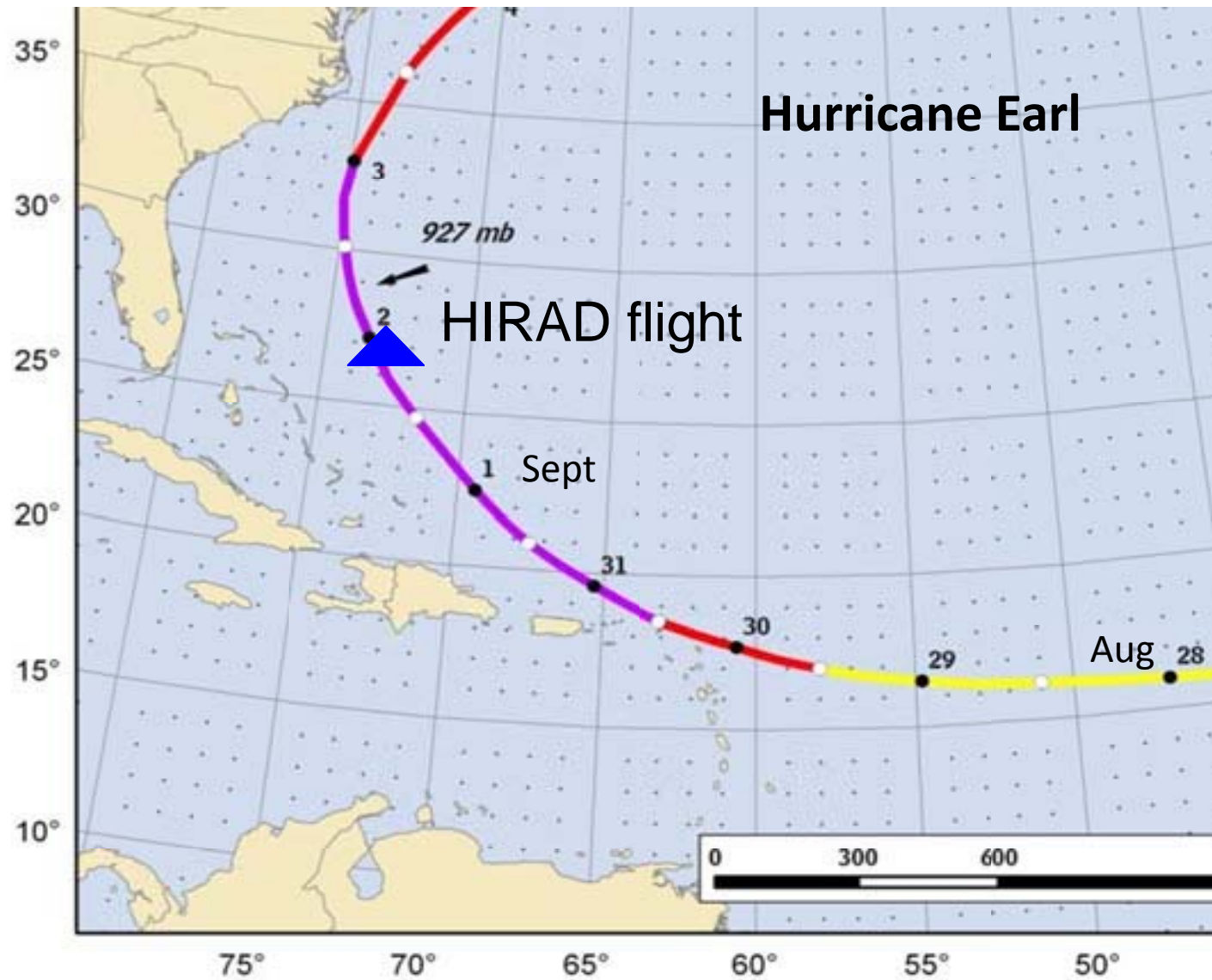
HIRAD flights during GRIP

- Platform: WB-57, based in Houston
- Flights:
 - Late 1 Sept (Earl), deployed from Tampa
 - Major objective: Coincident measurements with P-3 (SFMR)
 - 14 Sept (Karl) – Just after Karl named, prior to crossing Yucatan
 - 16 Sept (Karl) – Storm in the “middle” of the Bay of Campeche; best Karl flight
 - 17 Sept (Karl) – Just after landfall

Processed so far: Earl 1 Sept, Karl 16 Sept, 5 GHz only

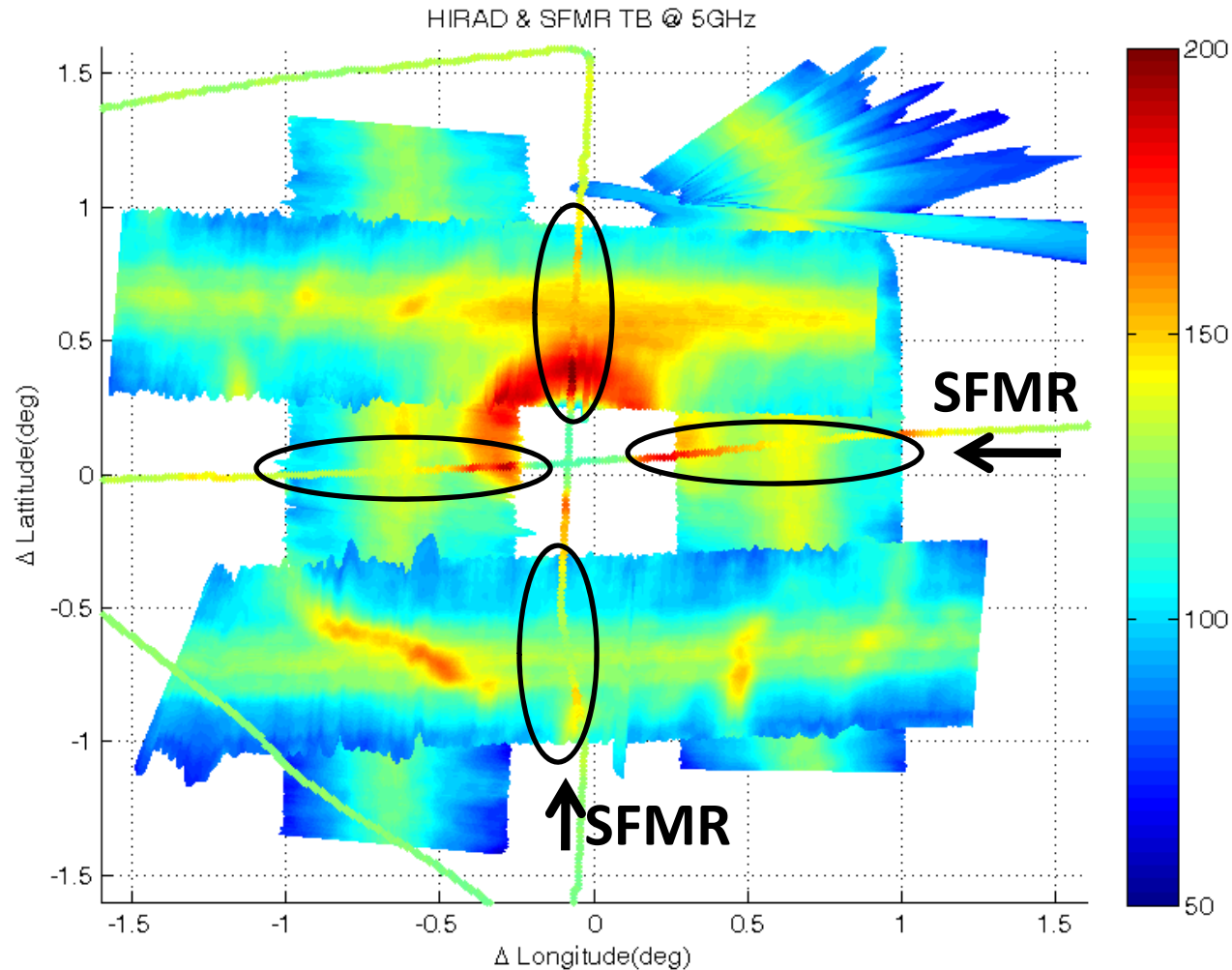
- **Earl 1-2 Sept:**
 - HIRAD's first flight; objective: validation obs with P-3's SFMR (fly box around vortex)
 - Over-storm time period: 23:20 – 01:35
 - SFMR crossed complete HIRAD swaths 4 times, including north and west parts of eyewall
- **Karl 16 Sept:**
 - HIRAD made 5 overpasses of the vortex (offset from center)
 - Comparison with P-3 radar verifies HIRAD capture of geophysical features

Hurricane Earl



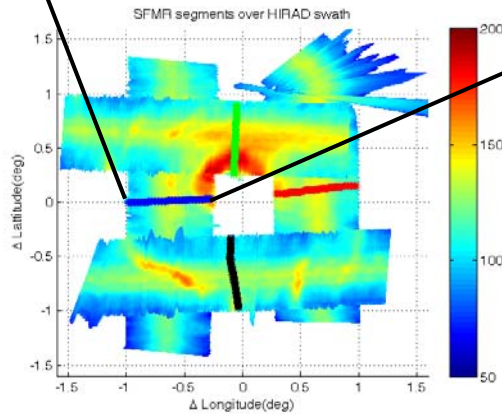
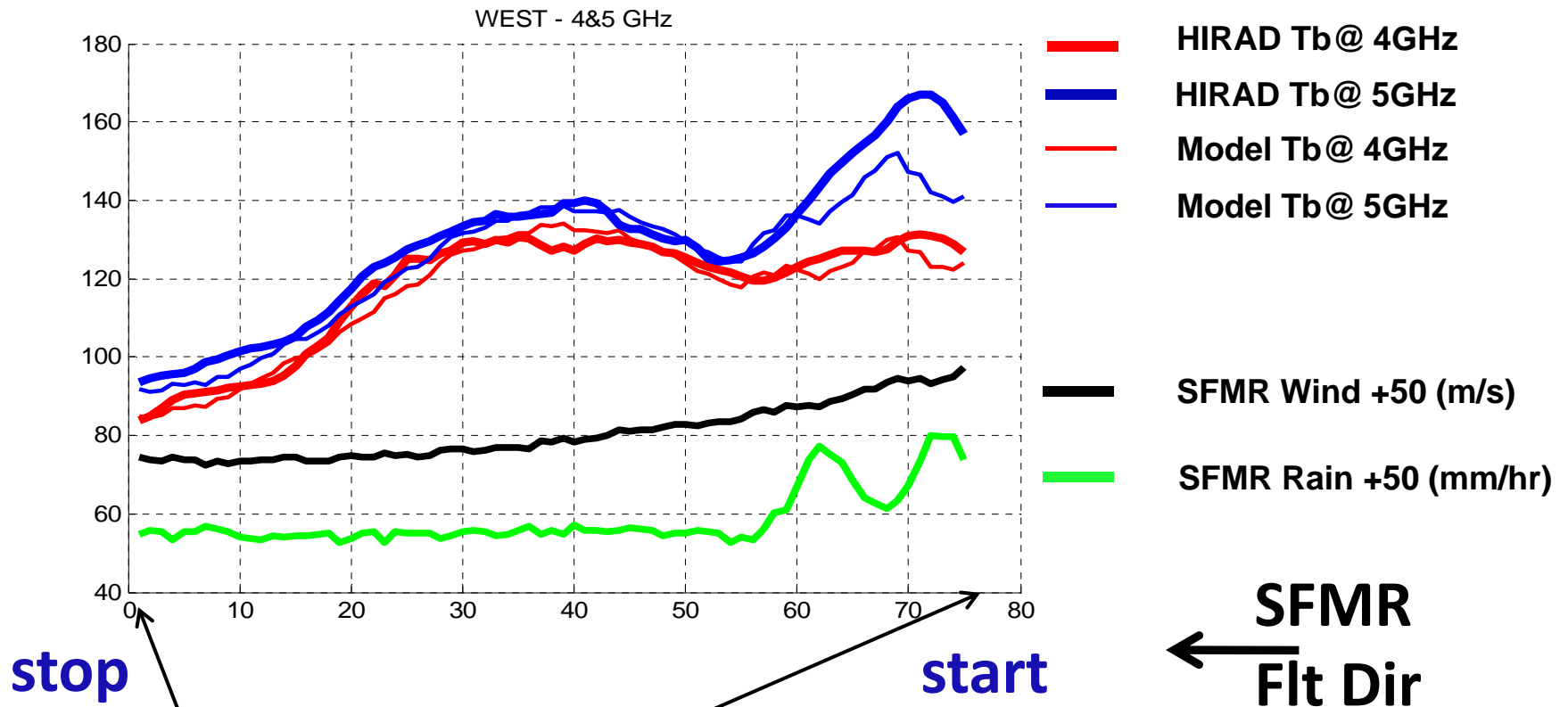
SFMR passes over HIRAD swath

Storm-centric coordinate system



HIRAD and SFMR should match at HIRAD's nadir point

HIRAD/SFMR West Leg Overpass



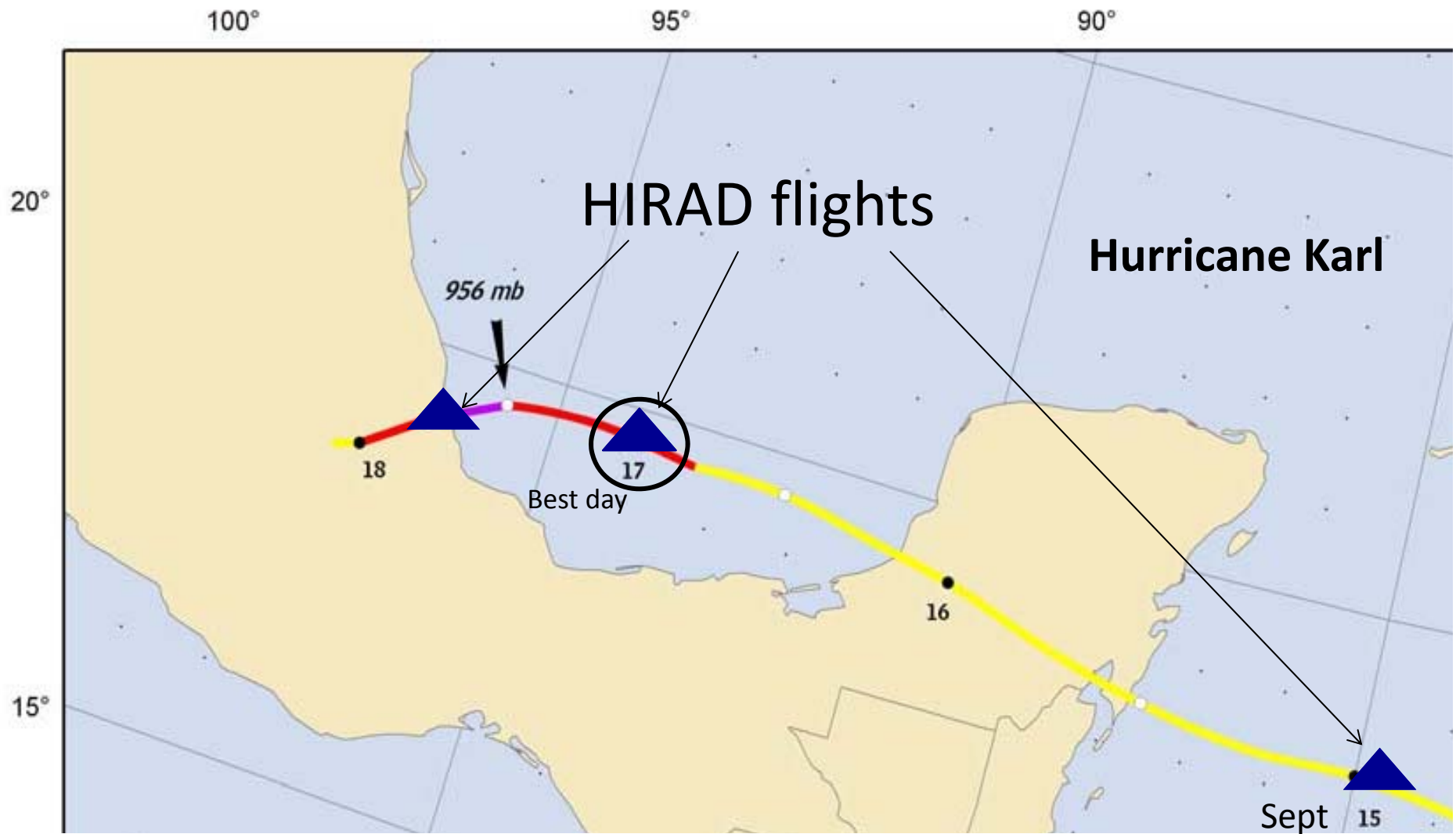
“Model” data are T_B s computed from SFMR wind & rain fields (using HIRAD view geometry)



UCF



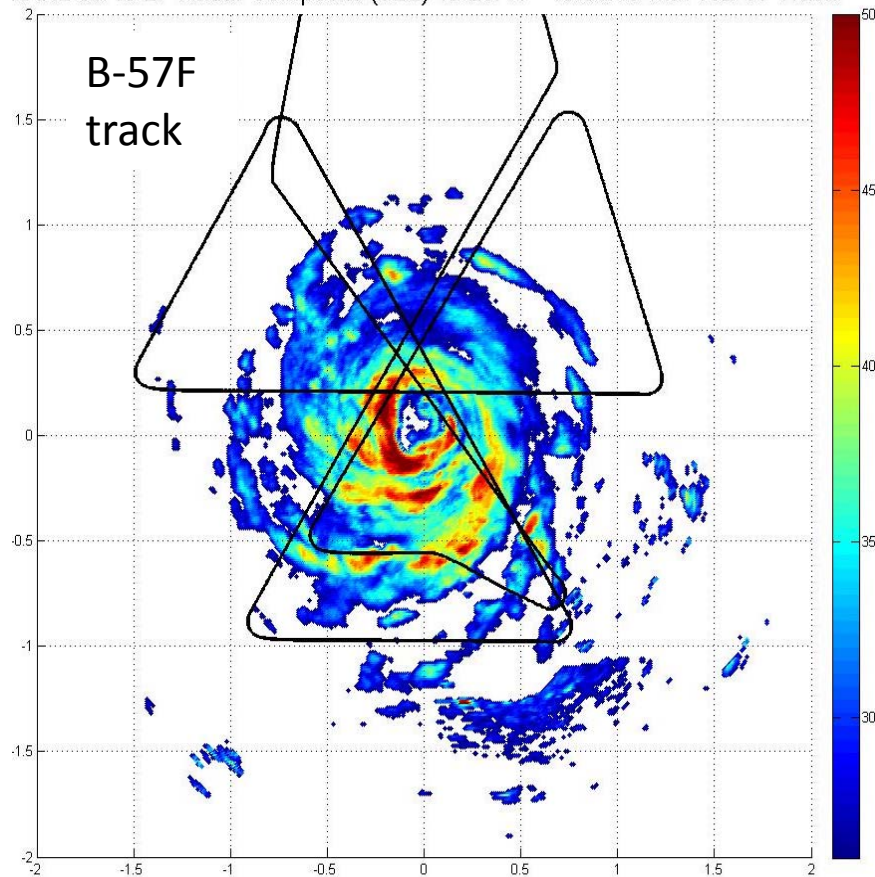
Karl Best Track



Sept 16 Karl flight

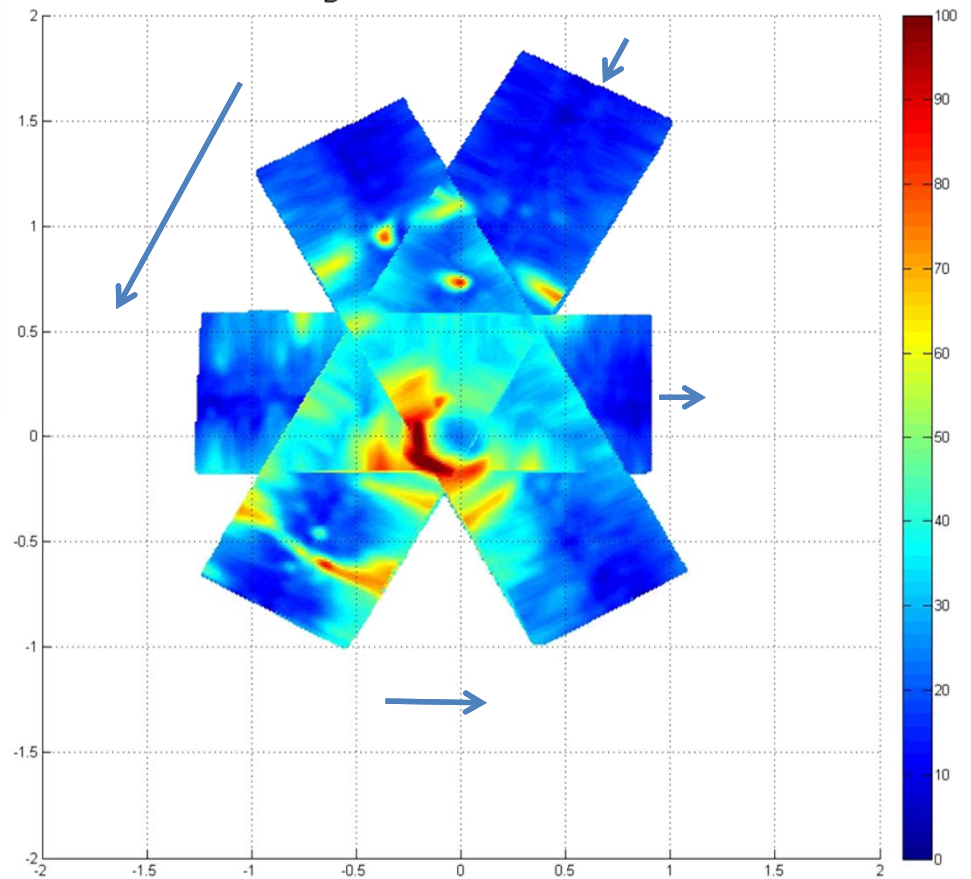
P3 radar reflectivity (left)
HIRAD excess T_b 5 GHz (right)

KARL 09/16 LF Radar Composite (dBz) 19:23:41 - 19:33:49 with WB-57 Track



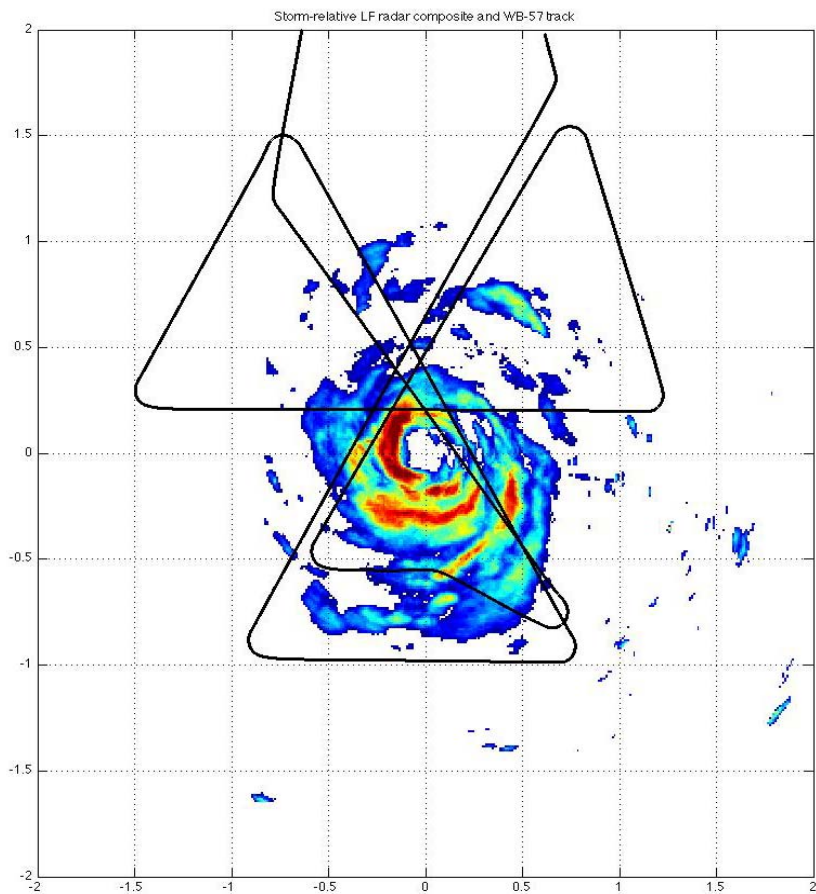
P3 radar center crossing ~19:30:20

HIRAD 5 GHz excess T_b filtered 16 Sep Karl legs 2, 4 and 6, 65 deg

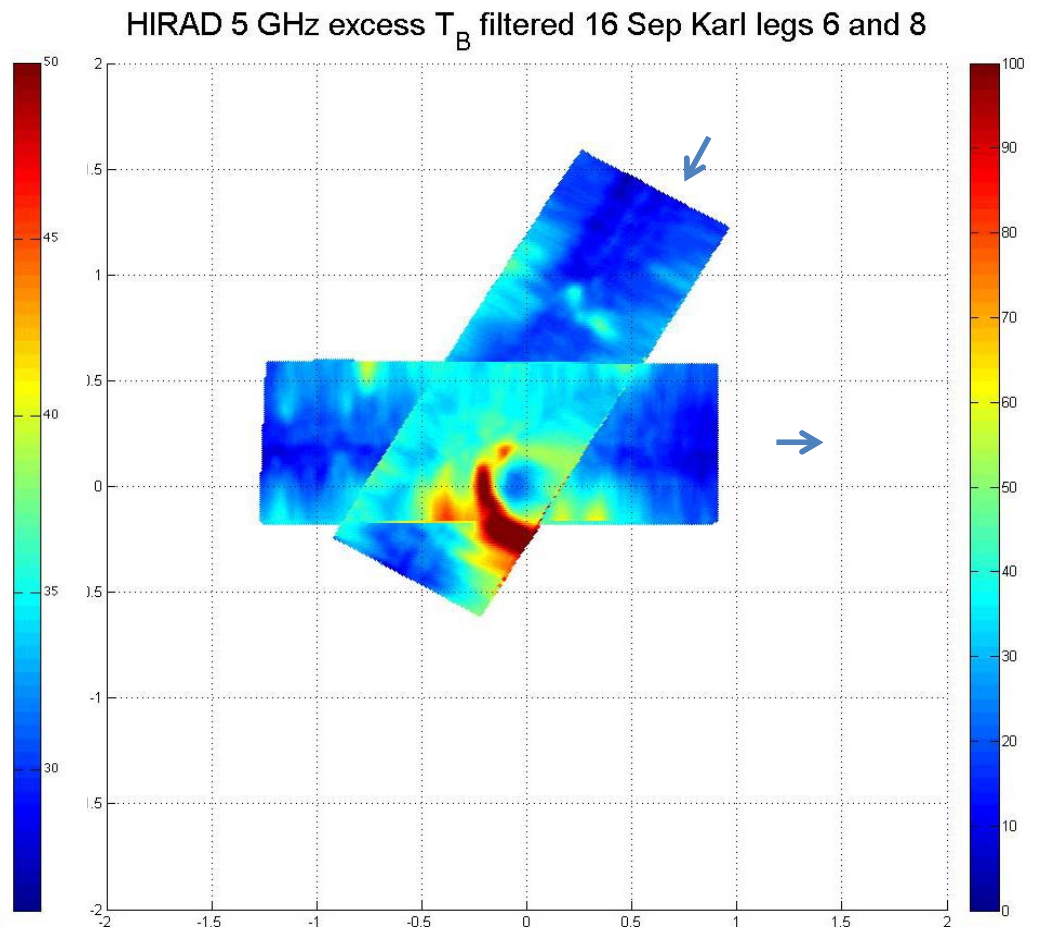


WB-57 HIRAD center crossings at
19:16:49, 19:52:37, 20:33:44

Later in the flight



P3 radar center crossing ~20:42:08

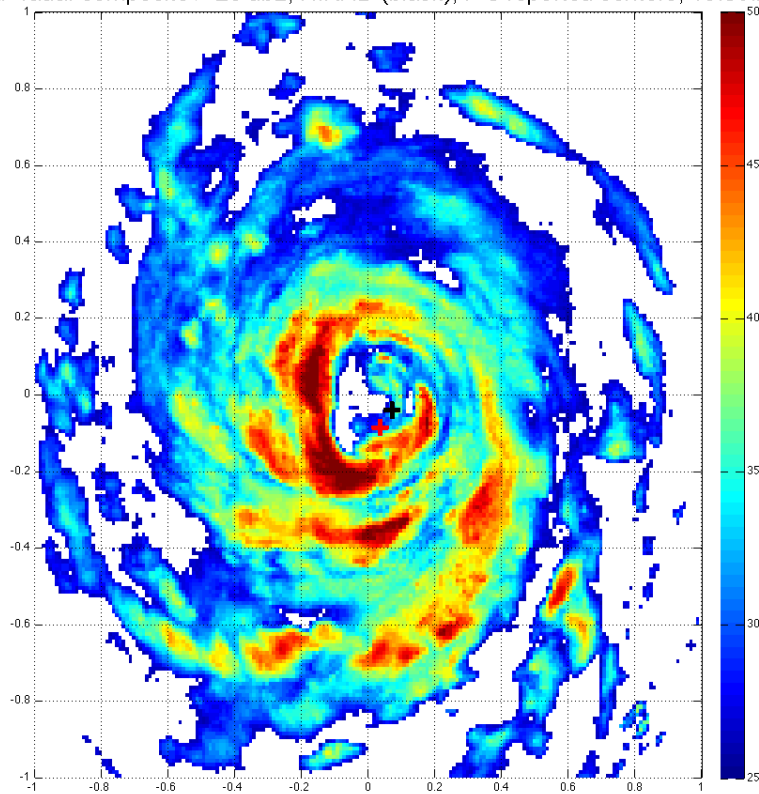


WB-57 HIRAD center crossings at
20:33:44 and 20:53:40

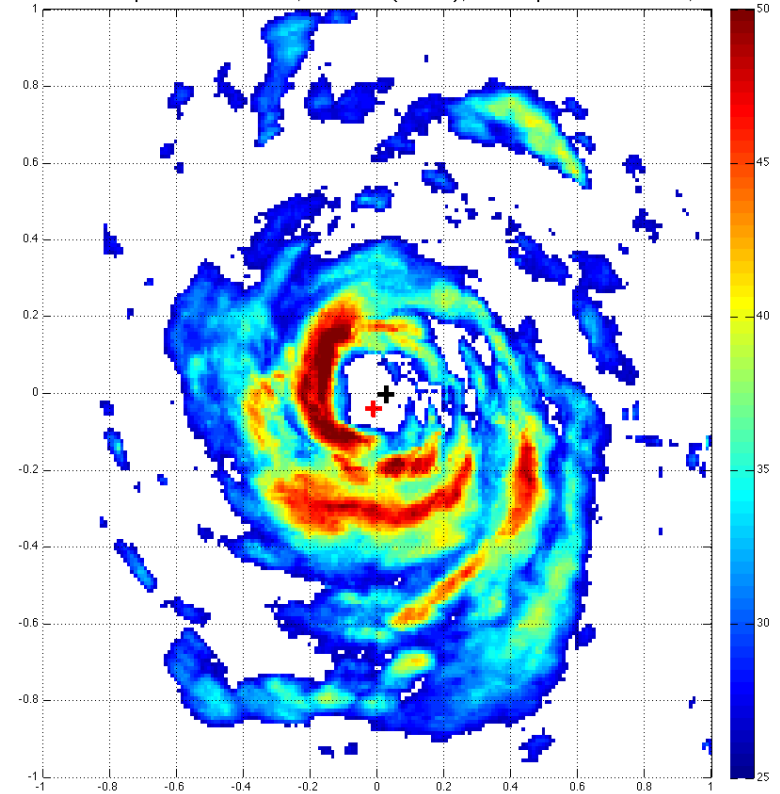
Composite P-3 LF radar reflectivity

Karl 16 Sept 2012

P-3 LF radar composite > 26 dbz; HIRAD (black), P-3 reported centers; 19:30:20

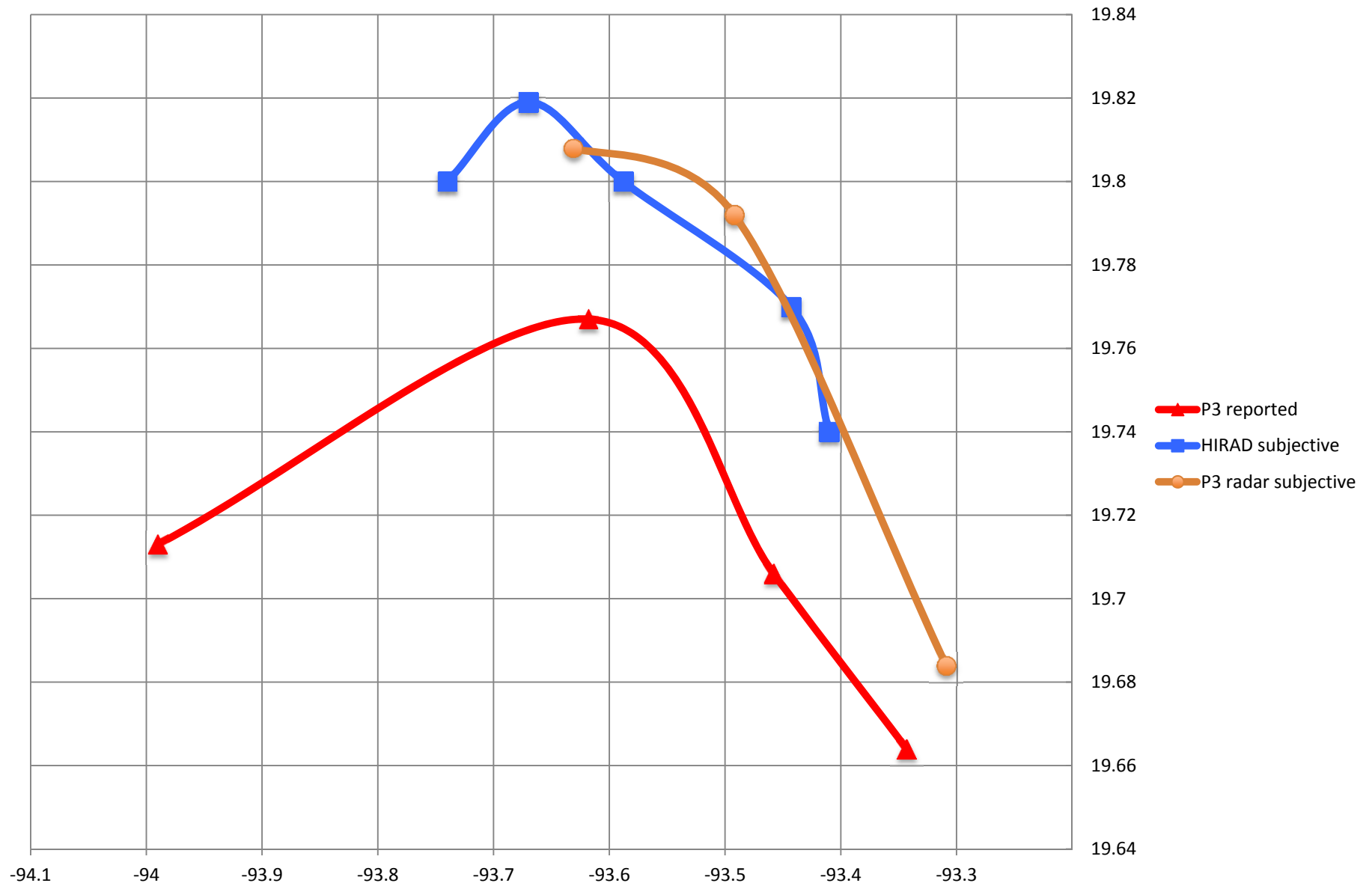


P-3 LF radar composite > 26 dbz; HIRAD (black), P-3 reported centers; 20:42:08



Red "+" is P-3 reported center; black "+" is HIRAD center

Karl 16 Sept Center Position



GRIP Calibration and Data Analysis

(more details in Chris Ruf poster)

- Rain rate and wind speed retrievals require at least two calibrated frequencies
 - 5 GHz T_b s (microwave brightness temps) have been successfully produced
 - Calibration of other 3 channels is work in progress; further instrument tests are underway to enable calibration and data production
 - Geophysical model function (GMF) developed by UCF (Jones) and HRD (Uhlhorn) will be used to retrieve rain and wind, after T_b calibration is complete
- HIRAD calibration issues and mitigation for HS3
 - Calibration uses internal reference blackbody targets and noise diodes
 - Dependence of calibration algorithm on reference T_b has uncorrected instrument temperature dependence ($\sim 25^\circ$ C variation during GRIP flights)
 - Temperature correction algorithm being developed for GRIP (requires additional instrument characterization testing)
 - Thermal control subsystem being upgraded for HS3 to greatly reduce instrument temperature fluctuations
 - More temperature measurements are being added to the instrument
 - Chamber tests will be conducted this summer in preparation for HS3

Summary

- HIRAD had successful flights over Earl and Karl
 - Best flights 1-2 Sept and 16 Sept
 - 14 Sept flight was cut short prior to reaching storm center
 - 17 Sept flight was after center had made landfall, winds were much weaker
 - T_B comparison with SFMR and with radar features are very encouraging
 - More details in Pete Black's poster
 - Data analysis is still ongoing
 - 5 GHz looks good for Earl and for 16 Sept Karl, and data have been deposited to the GRIP archive
 - Other frequencies require additional work, after which wind speed and rain rate will be retrieved
 - More details about calibration challenges in Chris Ruf's poster
 - We hope to complete the analysis before Aug. 1